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ABSTRACT

A sequel to the booklet "A Review of the Different Types of Instructional Materials Available to Teachers and Lecturers," this booklet begins by looking at how audio materials can be used in different types of instructional situations, i.e., mass instruction, individualized learning, and group learning. The basic principles of sound recording and editing are then presented, including: (1) how sound is recorded on audiotape; (2) the equipment needed for audiotape recording, such as various types of microphones and tape recorders; (3) different types of tape; (4) general rules for making a recording; (5) methods for editing tapes; and (6) producing duplicates and multiple copies of tapes. The booklet concludes by presenting guidelines for designing and producing audio materials for specific instructional purposes, which may be categorized as illustrative/background, expository, management-of-learning, or interactive. An annotated list of three items recommended for further reading is included. (MES)

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How to Produce Audio Materials

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How To Produce Audio Materials

Introduction

In this booklet, we will examine the fourth category of instructional materials that we identified in "A review of the different types of instructional materials available to teachers and lecturers" – *audio materials*. In their own way, these have had just as great an impact on instructional methodology as any of the visual media discussed in earlier booklets – both as instructional vehicles in their own right and as a component of linked audio and visual systems such as tape–text and tape–slide.

We will begin by taking a general look at how audio materials can be used in different types of instructional situation. Then we will turn our attention to the most important class of audio materials– *audiotapes* – examining the basic principles of audiotape recording and editing and showing how audiotape–based materials can be designed and produced for specific instructional purposes.

How Audio Materials Can Be Used In Different Teaching/ Learning Situations

In the second booklet in this series – "A guide to the selection of instructional methods" – we saw that instructional methods can be divided into three broad classes – *mass instruction techniques, individualised learning techniques and group learning techniques*. Let us now see what role audio materials are capable of playing in each of these different types of instructional situation.

Mass Instruction

Here, we can identify at least three highly important roles for audio materials. The first is as a source of supportive and illustrative material for use in expository teaching – recorded music, poems and plays, recorded extracts from talks and speeches, foreign languages spoken by native speakers, and so on. Such materials can be used in all situations where an audio input of some sort would increase the effectiveness of the instructional process – or simply help to maintain student interest and concentration by varying the method of presentation.

The second way in which audio materials can be used is as the actual vehicle by which the mass instruction is carried out. Examples of such mediated instruction include the various types of educational radio broadcast, either used 'off air' or recorded on audiotape for

use at a more convenient time or more appropriate stage in the curriculum, and the wide range of pre-recorded lessons and lectures that are available on record or audiotape. Self-contained 'audio lessons' of this type – and similar lessons produced 'in house' by a teacher or instructor – can, on occasions, be a highly effective substitute for a live exposition.

The third main method of using audio materials in mass instructional situations is as a vehicle for enactive learning of some sort. Examples include the use of tape recorders to record simulated interviews, debates, scenes from plays, musical performances, and so on for subsequent replay, discussion or criticism. Other examples include the use of audio materials in language laboratories and similar 'electronic classroom' situations.

Individualised learning

If anything, audio materials are capable of playing an even more important role in individualised instruction than in mass instruction, either on their own or in conjunction with visual media of various types. Here, they can again be used in at least three basic ways. The first is as a vehicle for conveying the actual content of the instruction to the learner, with the learner having a more-or-less passive role, and merely having to listen to the material. Most educational radio broadcasts fall into this class, as do many self-instructional audiotapes and records. The second is as means of *managing* the instructional process, with the audio material (usually an audiotape) acting as a sort of 'talking study guide' that is used in conjunction with other materials such as textbooks, notes and worksheets. The third is similar to the third role described in the 'mass instruction' section, with the audio materials providing a vehicle for enactive learning in which the learner actually has to interact with the materials themselves. Most self-instructional systems for learning foreign languages fall into this last category, with the audio material with which the learner has to interact being supplied on a gramophone record or audiotape.

Group learning

Audio materials can also play an extremely useful role in many types of group learning activity. Here, they can again be used in three basic ways:

- As a vehicle for supplying information to the group, either of an illustrative or supportive nature or as part of the main content of the exercise;

- As a vehicle for managing or guiding the group through the exercise;
- By providing a vehicle with or through which the members of the group have to interact.

The basic principles of sound recording and editing

Of the main purely audio media (radio, gramophone records and audiotapes), the only one where it is really practical for teachers and lecturers to produce their own materials is the last. We will therefore devote the remainder of this booklet to the production of audiotapes, beginning by taking a fairly detailed look at audio recording and editing and then showing how to produce audiotape-based materials for specific instructional purposes.

How sound is recorded on audiotape

The various processes that take place in audiotape recording and playback are shown schematically in figures 1 and 2 respectively.

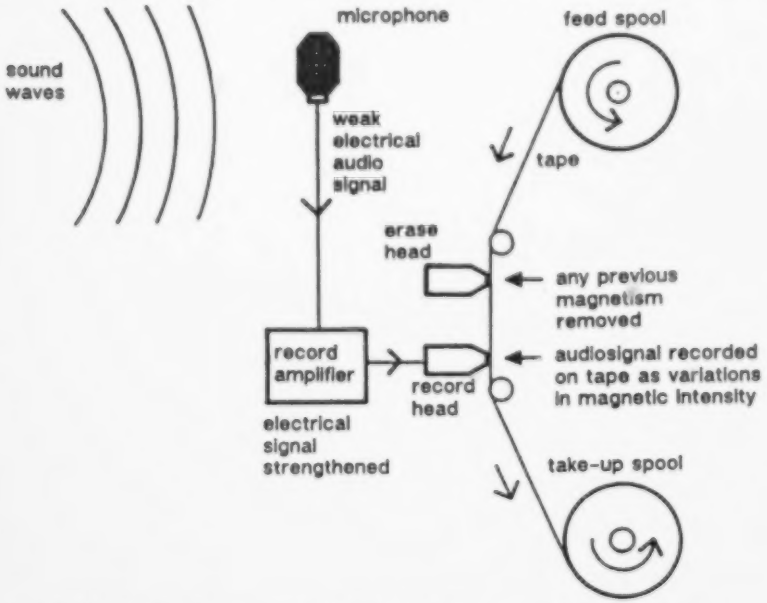

Figure 1 : schematic representation of the various stages of audiotape recording

In the recording process, the first stage takes place in the *microphone*. Here, the incident sound waves cause a membrane of some sort to vibrate, and these mechanical vibrations are converted into a weak electrical signal whose amplitude follows the amplitude of the original sound exactly (a so-called *analogue* signal). Next, the electrical signal is passed into the *record amplifier* of the tape recorder, where it is increased in strength and (in most cases) also has its high frequencies artificially enhanced in order to increase the *signal-to-noise ratio* in the final recording. The signal is then fed into the *record head*, an electromagnet that produces between its poles a magnetic field whose intensity varies in exactly the same way as the amplitude of the electrical sound signal. The recording tape is coated with a thin layer of magnetisable material such as iron oxide or chromium oxide powder, and, as it passes across the narrow gap between the poles of the record head magnet, has the signal recorded on its surface in the form of a weak magnetic field with the same intensity profile as the original sound.

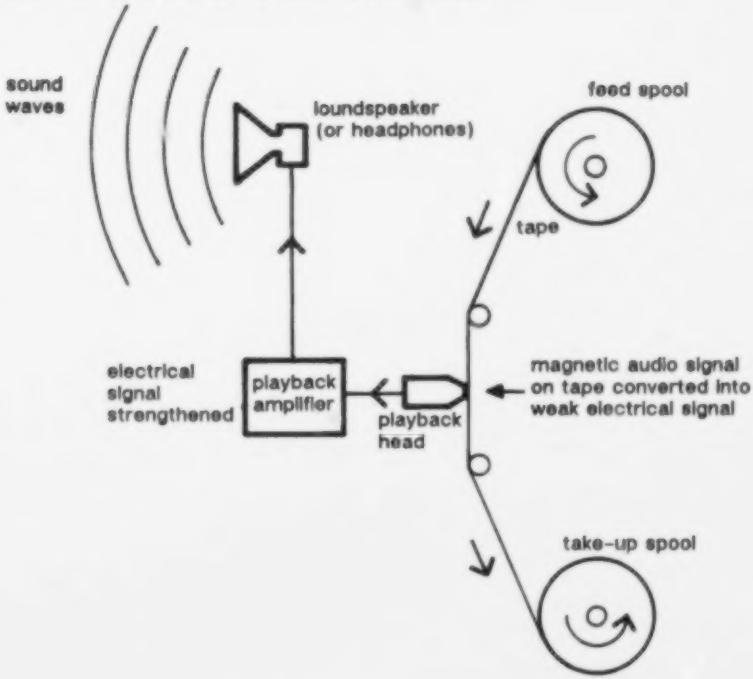

Figure 2 : schematic representation of the various stages of audiotape playback.

In the playback process, exactly the opposite chain of transformations takes place. First, the tape moves across the surface of the *playback head*, an electromagnet with a similar structure to the record head. Here, the variations in magnetic intensity as the tape crosses the gap of the head cause a weak electrical signal to be induced within the head. This is then passed into the *playback amplifier*, where it has its strength greatly increased, and also has any artificial boosting of the high frequencies that was introduced during the recording stage removed. The electrical signal is then passed into a *loudspeaker*, where it is converted into mechanical vibrations of the loudspeaker cone. These, in turn, produce sound waves that are (in a high-quality system) almost an exact reproduction of the original sound that impinged on the microphone. Alternatively, the electrical signal can be fed into a set of *headphones*, which are simply two miniature loudspeakers designed for individual listening.

The equipment needed for audiotape recording

To record material on audiotape, you require two basic items of equipment, namely, a *microphone* and a *tape recorder*. Let us now look at the various types that are available.

Microphones

Microphones come in an extremely wide range of types, and, like most other items of audiovisual hardware, vary enormously in quality and price. Thus, when buying or selecting a microphone, it is important to choose one that is of a suitable type to do the job that you have in mind and is also of a quality that matches the rest of your equipment. Clearly, buying a cheap, low-fidelity microphone for use with an expensive, high-fidelity tape recorder is a false economy, since any audio system is only as good as its weakest link. Conversely, there is no point in buying a highly expensive microphone for use with a cheap tape recorder that will not be able to do justice to the signal that it produces. For most purpose, a microphone costing around £20* is perfectly adequate. (*All prices given in this booklet are 1987 prices.)

Microphones differ both in terms of the basic physical principles on which they operate and in terms of their directional characteristics. With regard to the latter, we can distinguish four main types.

- *Omnidirectional microphones*, which are equally sensitive in all directions when suitably mounted; suitable for recording group discussions and in other situations where the sound comes from all directions.

- *Bidirectional* (or *figure of eight*) *microphones*, which are sensitive in two opposite horizontal directions but not in directions at right angles to these; suitable for recording interviews involving two people, with one on either side of the microphone.

- *Cardioid microphones*, which are highly sensitive in one direction, somewhat less sensitive in directions at right angles to this, and not sensitive at all in the opposite direction; suitable for recording a single speaker, a choir, or any other sound source where the sound effectively comes from a single direction.

- *Gun* (or *rifle*) *microphones*, which are highly directional in their sensitivity, only picking up sound within a narrow cone; suitable for picking up sound from a single source located some distance away.

Tape Recorders

These are of two basic types, namely *open-reel* recorders and *cassette* recorders. The former make use of detachable open reels as feed and take-up spools, and generally have to have the tape threaded manually through the tape head and drive mechanisms before use. The latter make use of sealed tape cassettes that contain both the feed and take-up spools, and are loaded simply by fitting the cassette into place in the machine. Apart from this, however, the two types of recorder work in exactly the same way, and can be used to do more or less the same things.

The other main way in which the two types of tape recorder differ is in terms of the *track configuration* of the tapes that they use. In the case of open-reel machines (which use $^1/_4$" tape) there are five main configurations that you are likely to come across:

- *Full track monophonic* : only one recording track, covering virtually the entire wide of the tape, so that such tapes cannot be turned over in order to record on 'the other side'. (Note: this system is only used in highly-expensive tape recorders of 'broadcast' quality – the type that are used by professional sound engineers and broadcasters.)

- *Half-track monophonic* : two recording tracks, one on each half of the tape, with only one being used at a time; reversing the tape (i.e. turning it round so that the take-up spool becomes the feed spool) brings the other track into use. (This is the system that is used in most high-quality single-channel audio work.)

- *Half-track (two-track) stereophonic* : two recording tracks, with one being used to record each channel of a stereophonic signal (or separate signals.)

- *Quarter track (four track) stereophonic* : four recording tracks, with tracks 1 and 3 being used when the tape is used as shown in figure 3 and tracks 2 and 4 being used when it is turned over.

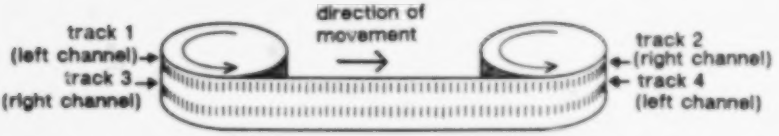

Figure 3 : the track configuration on quarter track stereophonic open-reel tape

- *Multi-track* : four or more separate tracks, each used to carry a separate sound signal.

In the case of cassette machines (practically all of which now use standard *compact cassettes* containing tape 4 mm wide) there are two main configurations:

- *Monophonic* : two recording tracks, one on each half of the tape, with the lower track being used when 'side A' of the cassette is used and the upper track when 'side B' is used.

- *Quarter-track (four-track) stereophonic* : four recording tracks, with the bottom two tracks being used when 'side B' is used (see figure 4); note the difference between this and the corresponding open-reel configuration.

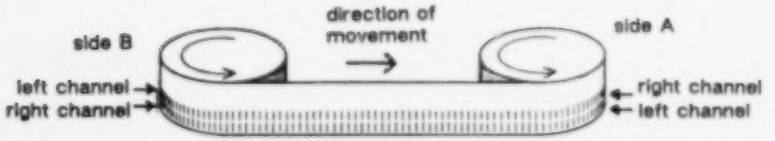

Figure 4 : the track configuration on quarter track stereophonic cassette tape

When choosing a tape recorder for a particular purpose, you should be aware of these different track configurations and select a machine that is capable of doing the job you have in mind. For making original recordings, it is strongly advisable to use an open-reel machine, since these not only produce better quality recordings than cassette machines of similar price but also make editing very much easier, as we will see later. Unless you have to produce material of 'broadcast'

standard (in which case you will have to invest something of the order of £1500 in a full-track machine), you will probably find that a half-track monophonic recorder costing roughly £200 is perfectly adequate for most purposes. For making master tapes, either an open-reel or cassette machine may be used, but it is again important to choose one of reasonable quality, otherwise fidelity will be lost during the transfer process. If you already have a good open-reel machine, it would probably be best to buy a general-purpose four-track stereophonic cassette recorder for this purpose, preferably one with pulsing facilities, so that you can use it for tape-slide work. Such a machine can again be obtained for around £200. For playing a recording back to a class or group, it is again advisable to use a machine of reasonably high quality – preferably one with an external loudspeaker, since machines with built-in speakers can be difficult to hear clearly from the back of a room. When choosing machines for individual use, on the other hand, cheap monophonic cassette players (costing as little of £20 each) may well be all that is required, since quality of reproduction is normally not nearly so important when tapes – particularly ones carrying spoken material – are being listened to through headphones. Such machines can be used to play both monophonic and stereophonic tapes. With the latter, the mono head simply picks up the signals from the two stereo tracks (which occupy the same area as a mono track) and reproduce them as a single combined signal.

The different types of tape

The magnetic tape used in audio recording consists of an insulating base material (usually some form of plastic, mylar or polyester) coated with a thin layer of magetisable powder. In most tapes, the latter consists of particles of ferrous oxide, but some high-quality tapes use the more expensive chromium dioxide, since this produces less background noise (tape hiss) and gives a higher sound output level and a higher fidelity recording. Most high-quality tape recorders incorporate a switch that enables circuits suitable for use with the two different types of tape to be selected.

In the case of open-reel tapes, three different grades of tape are available, namely *standard* or *1.5 mil* tape (tape with a thickness of 1.5 thousandths of an inch), *long-play* or *1.0 mil* tape, and *extra-long-play* or *0.5 mil* tape. Clearly, the length of tape that can be wound on a spool of a given size (and hence the playing time at a given speed) depends on this thickness, with a 1.0 mil tape giving 50% more playing time that a 1.5 mil tape on a reel of the same size and a 0.5 mil tape giving 100% more. On the other hand, thicker tapes produce better-quality recordings with less *print through*

(unwanted transfer of the signal from one layer of the tape to the next), and also tend to last longer. Thus, it is advisable to use 1.5 mil tapes for original and master recordings, although 1.0 mil tape can be used in the case of long programmes. 0.5 mil tape is not recommended for high-quality work; indeed, some tape recorders cannot handle such tape at all. The following table shows the playing times that are available with different sizes of spool of the three thicknesses of tape.

Type of tape	Diameter of reel (inches)	Length of tape (feet)	Playing time at $7^1/_2$ ips	Playing time at $3^3/_4$ ips
standard (1.5 mil)	5	600	15 min	30 min
	7	1200	30 min	60 min
long-play (1.0 mil)	5	900	$22^1/_2$ min	45 min
	7	1800	45 min	90 min
extra-long play (0.5 mil)	5	1200	30 min	60 min
	7	2400	60 min	120 min

In the case of compact cassettes, the cassette is designated with a number that shows its total playing time in minutes if both sides are used. The most common sizes are as follows:

C 30 - playing time 15 min. per side
C 45 - playing time $22^1/_2$ min. per side
C 60 - playing time 30 min. per side
C 90 - playing time 45 min. per side
C120 - playing time 60 min. per side

As in the case of open-reel tapes, the thickness of the tape in cassettes with very long playing times is less than for short-play cassettes, with an associated reduction both in quality and in durability. Indeed, C 120 tape is so thin that it tends to jam many machines, and is not recommended for instructional use.

One final word of warning about buying tapes. It is seldom advisable to try to economise by buying cheap tapes, since these not only produce a lower quality of recording and are, in many cases, prone

to jamming, but can also cause excessive wear and fouling up of the recorder heads. Thus, always buy good-quality tapes from a reputable supplier; it will pay you in the long run.

How to make a recording

The way in which you set about making a recording on audiotape will obviously depend to a large extent on the nature of the material to be recorded and the purpose for which it is to be used. There are, however, some general rules that should always be observed.

1. *Make sure that what you are recording is of the highest possible quality.*

   This is a fairly obvious point, but one that is all-too-often neglected. In most cases, the key to producing high-quality original material is careful preparation, both in terms of planning and writing the materials and in terms of making sure that the presenter(s) or performer(s) are thoroughly briefed and rehearsed. If you are recording spoken material, it is also important to use a presenter with a good, clear delivery – preferably someone who has had training in and/or experience of such work. If at all possible, try to obtain the services of a professional presenter (e.g. an obliging local radio announcer) for any particularly important recording work, since this can make a tremendous difference to the quality of the final product.

2. *Try to optimise the recording environment.*

   If you want to produce a good-quality recording, it is absolutely essential to carry out the recording work in a suitable environment. First (and most important) it *must* be free from extraneous noise. Remember that a human listener automatically 'filters out' unwanted background noise by concentrating exclusively on what he or she wants to hear, but that a tape recorder does not, faithfully recording every sound that falls on its microphone. Thus, background noise that is hardly noticed at the time a recording is being made can prove intolerable when the resulting recording is played back. Second, the environment should have appropriate acoustic properties, being neither too reverberant (as in a swimming pool) nor too 'dead' (as in a heavily carpeted and curtained room full of soft furniture). If you are not sure whether the environment is satisfactory, carry out a trial recording, and, if something is obviously wrong, try to improve matters by judicious use of acoustic screens, absorbent materials, and so on. Even a few coats hung in strategic positions round a microphone can sometimes make all the difference, as can the

siting of the microphone in an open-ended box lined with absorbent materials such as felt or foam rubber. In some cases, of course, it may be better to move to a completely different location, e.g. by recording narrative material in a quiet room at home rather than trying to compete with the inevitable background noise that is present in most working environments.

3. *Use appropriate equipment and materials.*

This, of course, is absolutely fundamental, for if you use inappropriate equipment or unsuitable tape, the resulting recording will invariably turn out to be not as good as it might be. Thus, you should always:

- Use an external microphone (*not* one built into the tape recorder) of sufficient quality to do justice to the rest of the equipment – preferably one with directional properties suitable for the job you want it to do (an omnidirectional microphone for group work, a bidirectional microphone for interviews, a cardioid microphone for a single speaker or unidirectional sound source, and so on).
- Use the best tape recorder available, assuming it is suitable for the job in hand and bearing in mind that open-reel machines are generally much more suitable for making original recordings than cassette machines.
- Use a good-quality tape of suitable grade and of sufficient length to give the required playing time at the tape speed you intend using.

4. *Get the most out of your equipment and materials.*

Even if you buy the finest equipment on the market, you will only obtain good results if you use the equipment correctly. Thus, if you want to get the most out of your equipment and materials, you should:

- Select a tape speed that is sufficiently high to produce the quality of recording you require. With compact cassette recorders, the tape speed is fixed (at $1^{7}/_{8}$ ips), but with open-reel machines, it can be set at various values (usually $1^{7}/_{8}$ ips, $3^{3}/_{4}$ ips, $7^{1}/_{2}$ ips and 15 ips). With such machines, the quality of the resulting recording increases as the tape speed increases, especially in terms of high-frequency response, so you should always make sure that this speed is high enough to produce satisfactory results. When recording speech, you will probably find that one of the lower speeds is perfectly adequate, but you will

probably have to use a higher speed when recording music if you want the fidelity of the recording to be high. Also, you will probably find that you need to employ higher tape speeds with older tape recorders than with more modern machines; the latter have smaller gaps in their heads, and thus give a better frequency response at a given tape speed.

- Set the recording level correctly. Some machines have a facility that allows this level to be controlled automatically, but this should *never* be used when recording speech or any other material that has periods of silence; during such quiet periods, the machine increases the gain of its input amplifier in order to try to bring the signal strength up to the required level, thus causing the background noise level to increase sharply. To prevent this, the recording level should always be set manually, using the relevant meter(s) or indicator(s) for guidance (these are incorporated in all but the cheapest machines). In most cases, the best setting is to have the *average* level just below the 'overload' area, so that the level only enters this area during peaks. If the level is much lower than this, the recorded signal will be too weak; if it is higher, you will probably find that the peaks are distorted.

- Use the 'pause' control for starting and stopping the tape during recording rather than the 'play' and 'stop' controls. Use of the latter almost invariably introduces unpleasant clicks and other forms of transient distortion into the recording, whereas use of the 'pause' control is (in the case of a good recorder) virtually unnoticeable.

How to edit tapes

Once material has been recorded on audiotape, it is often necessary to carry out some form of *editing* before the tape can be used, e.g. in order to remove bad takes, coughs and other unwanted sections, to insert pauses, or to rearrange the material in a different order. Such editing can be carried out in two ways, namely, by physically cutting up and rejoining the tape *(mechanical editing)* and by dubbing the signal from one tape to another *(electronic editing)*. Let us examine the two methods in turn.

Mechanical editing

Clearly, this form of editing can only be carried out on an open-reel tape (hence one of the reasons for using open-reel machines for original recording work), and only on tapes that carry a single recorded track. It is also much easier to carry out on tapes that are

recorded at a fairly high tape speed than on tapes recorded at a very low speed.

The method involves listening carefully to the recorded tape, noting the approximate position where cuts have to be made with the aid of the index counter on the recorder. The exact position of each cut should then be found by moving the tape manually backwards and forwards through the playback head and marking its position on the tape using a felt pen or chinagraph pencil. The final cutting and re-joining should be made using a *tape slicing block*, a cradle of non-ferrous metal that holds the ends of the tape precisely in position during the cutting and splicing process. Although a basic splicing block can be bought for as little as £5 or so, it may well be worth your while paying a good bit more than this (around £50 – £60) for a more sophisticated block that carries out the splicing virtually automatically. If you have to carry out a lot of mechanical editing, such a device can pay for itself fairly quickly in terms of time saved, and also produces a perfect join every time.

Electronic editing

Electronic editing should be carried out using two tape recorders, with the output signal of the one on which the original tape is being played being fed directly into the input of the one on which the edited tape is being recorded. Such editing should *never* be carried out by using a microphone to pick up the sound from the first machine, since this invariably causes loss of fidelity and reduction of the signal-to-noise ratio. Needless to say, the two recorders used should also be of fairly high quality. If the edited tape is to take the form of a master cassette from which using copies are to be made, it is probably best to edit straight from the machine on which the original material was recorded onto a good quality cassette machine.

When carrying out electronic editing, the output level of the first machine and the recording level of the second machine should be adjusted manually so as to produce a satisfactorily strong signal on the edited tape; the automatic recording level facility on the latter should *not* be used, since this leads to unacceptably high noise levels during silent or quiet sections (as we saw earlier). The two machines should also be started and stopped during the dubbing process by means of their 'pause' controls, since this avoids the clicks and transient distortions that can result from the use of the 'play' and 'stop' controls.

Mixing sounds from different sources

One advantage that electronic editing has over mechanical editing is that two or more separate sound signals can be simultaneously

recorded on the final tape if necessary. This is usually done by feeding the separate signals into a *mixer*, an electronic device that enables their relative volumes to be adjusted, and then feeding the output signal from the mixer into the actual recording machine. Such a system can be used to add background music, sound effects, etc. to a basic narrative.

Use of variable-speed recording

Another modification that can be made to recorded speech during electronic editing is alteration of the word rate. The normal speaking rate is roughly 150–200 words per minute (wpm), but research has shown that most people are capable of assimilating spoken information at a much higher rate than this without difficulty. By using a technique known as *speech compression*, such increases in word rate can be achieved without the rise in pitch and 'Donald Duck' distortion that results if the tape is simply speeded up. This involves passing the sound signal through special electronic circuits that remove tiny fragments from the sound at regular intervals and then join the remaining sections up to produce a shorter signal in which the words are presented at a greater rate. The process is illustrated in figure 5.

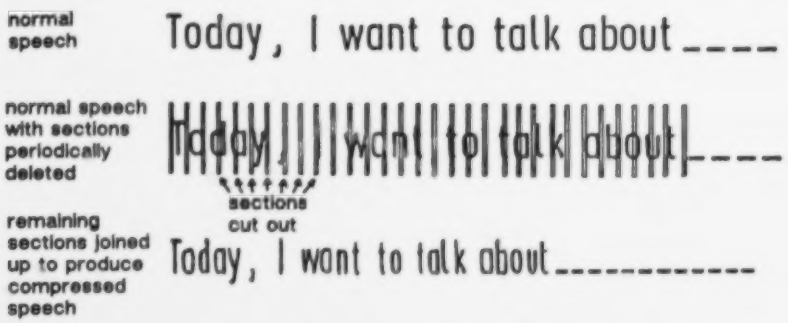
normal speech
Today, I want to talk about
normal speech with sections periodically deleted
sections cut out
remaining sections joined up to produce compressed speech
Today, I want to talk about

Figure 5 : the technique by which speech is compressed without distortion

By using this technique, it is possible to increase the speed of most spoken recordings by up to 50% without any appreciable loss of comprehension, although a somewhat smaller increase is probably advisable if the material is highly technical or otherwise intrinsically difficult or demanding. Clearly, use of speech compression can enable a greater amount of material to be covered in a given time or on a tape of given length. It can prove particularly useful in the preparation of material for individual listening.

A similar technique can be used to *reduce* the word rate of recorded speech. This involves chopping the original sound into short sections, moving these apart, and filling each gap with an extension of the previous section.

Producing duplicates and multiple copies of tapes

Once the final edited version of a tape has been produced, it is generally advisable to use it as a master for the production of one or more using copies, preferably in cassette form. Such copies can be produced in two ways. The first involves playing the master tape on one tape recorder and feeding the signal into a second recorder – a similar process to the electronic editing described above. This method can be used if only a small number of copies is required. The second method involves making use of special high-speed copying equipment that enables several copies of the tape to be made simultaneously. Use of such equipment is obviously advisable if a large number of copies is required.

When making copies of cassette tapes for use by individual listeners, it is, incidentally, often a good idea to record the material on *both* sides of the cassette; this saves the user from having to re-wind the tape after use – or the next user from having to re-wind the tape after someone else has failed to do so.

Many of the above aspects of audiotape recording are covered in an excellent series of leaflets written by N. Nichol and published by the Scottish Council for Educational Technology (see 'Further Reading' section at end of booklet).

How to design and produce audio materials for specific purposes

Now that we have dealt with the technical aspects of audiotape recording and editing, let us end this booklet by looking at how to design audio materials for specific purposes. As we saw earlier, such materials can be used in a large number of ways in different types of instructional situations, but it is possible to divide them into four broad categories:

- materials used for illustrative or background purposes;
- materials that constitute a mediated expository lesson of some sort;
- materials that are designed to *manage* an instructional process of some sort;

- materials that provide a vehicle with which learners can interact.

Let us therefore take a look at some of the basic principles that should underlie the design of each of these categories of materials.

Illustrative and background materials

Materials in this category, usually intended for use in mass-instructional or group-learning situations, come in an extremely wide range of types. They can include such things as recordings of pieces of music, poems, extracts from plays and speeches – anything, in fact, that a teacher or instructor feels will enhance the quality of a particular learning experience for a particular group of people. Because of the wide-ranging nature of materials of this type, it is clearly impossible to lay down highly detailed guidelines for their design and production. As with all other types of instructional materials, the key stages are:

- identification of the role that the materials are to play in the instructional situation;
- planning and/or design of materials that will be best suited for carrying out this role, including the preparation of a detailed script, if necessary;
- production of the actual materials.

Let us illustrate this process by considering a specific example – namely, an English teacher who wants to produce recordings of certain poems for use in a lesson on literary criticism.

Stage 1 : identification of instructional role of materials

Let us assume that our hypothetical teacher is planning to give a lesson on (say) the different styles of a given poet at different periods in his career, or on the contrasting styles of different poets in treating similar subjects. He or she decides that the best way to introduce the class to the poems would be to have them recited, and feels that the impact of the verse would be much greater if the recitations were fairly polished and 'professional'; hence the decision to pre-record them rather than to try to read or recite them 'from cold' at the actual time of the lesson.

Stage 2 : planning of materials

Clearly, the main thing that our teacher has to do here is decide exactly which poems (or extracts from poems) would be most suitable for use in the particular situation he or she has in mind, and also decide on the sequence in which they should be presented.

Next, it is necessary to decide who will carry out the recitations, some of the available options being:

- to perform the recitations him/herself;
- to get someone else to perform all the recitations (a colleague who has a particularly good speaking voice or a training in drama, for example);
- to get different people to recite different poems or extracts.

Whichever course of action is adopted, it is then obviously necessary to make sure that the presenter(s) is (are) thoroughly briefed and (if necessary) rehearsed, so that the actual recording will run smoothly.

Stage 3 : producing the materials

This should be done in the way described in the previous section, the various stages being:

- Selection of appropriate equipment and materials (microphone, tape recorder and tape);
- Selection of a suitable environment in which the recording can take place, and (if necessary) modification of that environment in order to improve its acoustic properties;
- Making original recordings of the various items;
- Editing these original recordings onto a master tape, and (if this is felt necessary) preparation of a using copy of same.

Expository materials

This category includes all the various materials that present a complete lesson, lecture or instructional sequence without reference to other materials such as textbooks or notes. In other words, the material conveys the actual *content* of the lesson, lecture or sequence to the learner as well as structuring the pacing the learning process.

When designing such materials, whether for use in mass instruction, individualised learning or group learning, the main thing to remember is that the material will be *listened to*, not *read*. Thus, it is necessary to adopt a somewhat different style of writing to that which would be appropriate for (say) a set of hand-out notes. The style should be conversational rather than formal, avoiding the use of long, convoluted sentences and complicated phraseology, which can make spoken material virtually impossible to follow. Try to make the

material easy for the listener to understand, repeating or reinforcing key points wherever possible, and making maximum use of illustrations and examples. Also, never forget that the material must be *completely self-contained*, incorporating *all* the content that you want to get across to the listener. Needless to say, this is particularly important in the case of audio materials designed for use in self-instructional situations, where there is no teacher or instructor on hand to amplify or explain what has been covered.

The planning and production of expository audio materials should be carried out in the same three stages as were described above for illustrative and background materials, namely (i) identification of their instruction role, (ii) planning and design of the materials, including (in this case) the preparation of a detailed script, and (iii) the actual production of the materials.

An example of a script prepared for a typical expository audiotape – the start of a 'tape lecture' on alternative energy – is given in figure 6. This shows the sort of style that should be used when writing such materials.

"In this tape, we will discuss the subject of 'alternative energy'. We will do so in four stages. First, we will explain exactly what is meant by the term 'alternative energy', since it often means different things to different people. Second, we will look at some of the reasons why people are now taking an increasing interest in alternative energy. Third, we will take a detailed look at some of the more important forms of alternative energy that are currently being developed or appraised. In this section, we will pay particular attention to alternative methods of generating electricity – probably the most important application of alternative energy. Finally, we will try to make a realistic assessment of the contribution that alternative energy sources are likely to make to our future energy needs – both in the short term and in the long-term".

(4 second pause)

"Let us now begin our examination of alternative energy by trying to establish exactly what is meant by the term. You probably have your own ideas about this already. For example, you have probably seen water mills and windmills – both of which rely on alternative forms of energy – water energy and wind energy – to produce their power. Also, you have probably seen the solar panels that many people are now fitting on their roofs in order to heat water. These, too, rely on an alternative forms of energy – in this case, the sun. What, then, is the thing that distinguishes these forms of energy – and all the other so-called 'alternative' sources of energy – from 'conventional' energy sources? The answer is really quite simple. Basically . . . . .

and so on

Figure 6 : the start of the script of a typical tape lecture

Management-of-learning materials

In practice, this category of materials overlaps with the other categories to a considerable extent, since many audio materials whose main function is to manage or structure an instructional process also contain illustrative or background material, expository material or materials with which the learners have to interact. Such materials are mainly used in individualised learning situations, although they are sometimes also used in group learning.

One of the most important uses of audio materials in the management of instruction is in the so-called *audio-tutorial* (or AT) system. Here, an audiotape serves as the central, managerial component of a multi-media, multi-activity study unit or module, and can perform a wide range of different functions, depending on the exact nature of the unit or module. These include:

- Providing information of one form or another;
- Directing the learner to various learning activities - reading sections of textbooks, examining materials, making observations, performing experiments, completing worksheets, and so on;
- Providing questions to which the learner has to reply, together with feedback on the answers.
- Providing 'extension material' that builds upon what has been learned from the other materials and activities in the unit, e.g. in the form of an in-depth discussion of important points.

The planning, design and production of the audio components of instructional systems of this type must obviously be carried out within the overall context of the design of the system as a whole. Again, the work should be carried out in the three basic stages described in the section on expository materials, namely (i) identification of the instructional role (or roles) of the audio components, (ii) the planning and design of the audio materials, including the writing of a highly detailed script, and (iii) the actual production of the materials.

Specific examples of the use of audio materials in conjunction with other materials are discussed in detail in booklet number 16 in this series ("How to produce linked audio and still visual materials"), but, in the meantime, a specimen script is given in figure 7. This is the start of an audio-tutorial on alternative energy, and should be compared with the tape-lecture script on the same subject that is given in figure 6.

"In this unit of the course, we will look at the subject of 'alternative energy'. The objectives of the unit are listed on page one of the accompanying text. Please stop the tape and read these when you hear the signal, starting the tape again once you have finished."
(Bleep, followed by 5 second pause)
As you have seen, the first objective of the unit is to enable you to explain exactly what is meant by the term 'alternative energy'. You probably have your own ideas about this even now, so would you please stop the tape when you hear the signal and write down, in not more than 50 words, what you think it is that distinguishes the so-called 'alternative' forms of energy from the so-called 'conventional' forms. Start the tape again once you have finished".
(Bleep, followed by 5 second pause

and so on

Figure 7 : the start of the script of a typical audio-tutorial

Materials with which learners have to interact

In this category, we include all the different audio materials that themselves provide a vehicle with which learners can interact. Probably the most important type are the various materials that are used as software in *language laboratories* and similar audio-electronic classrooms, so we shall concentrate on these in this section.

The different types of language laboratory

Before discussing the design and preparation of language laboratory materials, it would probably be useful to explain exactly what a language laboratory is and describe the main types that are currently in use. Essentially, a language laboratory is a facility that enables individual learners (working either alone or as part of a class or group) to listen to and respond to spoken material of various forms through the medium of a headset linked to a central or individual tape recorder. Three types of laboratory are in common use.

Audio-Active Comparative (AAC) Laboratories

These are full-scale class systems containing up to 30 individual carrels, each linked to a master console operated by the teacher or instructor in charge of the laboratory. Each carrel has its own tape recorder, as has the master console, from which all the individual carrels can be monitored or controlled, either singly or in groups. Such laboratories enable individual learners to work at their own pace, to rewind their own tapes and repeat sections if necessary, and – most important – to record and listen to their own responses (hence the word 'comparative' in the name).

Audio-Active (AA) Laboratories

These are again full-class systems comprising individual carrels linked to a master console, but differ from AAC laboratories in that the carrels are not equipped with their own tape recorders. Instead, the students receive their material from the master console. In such systems, the students can listen to and respond to material and can also hear their responses via their microphone and headphones; they cannot record their responses, however, and also have to work in lockstep at a pace controlled by the person operating the master console. Audio-active laboratories are very much less expensive to install and operate than audio-active comparative laboratories, and (somewhat surprisingly) appear to be almost as effective for most purposes.

Mini-Laboratories

A mini-laboratory consists of a single study unit, usually audio-active comparative and portable. Such units can be used independently for individual instruction, or can be linked with similar units to form a full-scale AAC laboratory controlled from a suitable master console. Flexible systems of this type are now becoming increasingly widely used.

Producing software for language laboratories

The design and preparation of software for use in language laboratories is a highly specialised business, and, in an introductory booklet of this nature, it is not possible to do any more than offer a few general guidelines.

First it is important not to regard a language laboratory merely as a tool for polishing pronunciation, practising grammar and similar routine (and uninspiring) activities. When properly used, such laboratories can provide learners with an interesting and highly-motivating means of improving their oral and aural performance, extending their vocabulary, and reinforcing general principles learned in open class. By individualising the learning process, they also tend to improve concentration, and, of course, provide each learner with far greater opportunities for personal language practice than would ever be possible in a conventional classroom situation. In all too many cases, however, the use of poorly-designed software and excessive use of 'drill and practice' at the expense of more interesting and demanding activities leads to student boredom and failure to get the most out of the system. Thus, it is vital that *all* language laboratory software should be extremely carefully planned and designed, taking full account of the role that it is intended to play

in the instructional process. Some of the basic activities that can be built into such software are given below.

- Pronunciation practice, in which the student is provided with a series of spoken exemplars which he has to try to imitate; here, some sort of four-phase pattern is probably best (*exemplar*; *student imitation*; *repeat of exemplar*; *repeat of imitation*).
- Structured pattern drills, in which the student is presented with a standard pattern (e.g. "il a mange une orange") and then has to repeat it with different subjects (elle, nous, vous, etc) or objects, use the same structure with different verbs, and so on.
- Sentence-building exercises, in which the learner is presented with different pieces of information or phrases that have to be structured into complete sentences.
- Questions and answers, ranging from simple questions asked in a highly-structured situation where the answer is fairly obvious to more open-ended questions where a variety of answers are possible (proper structuring of the debriefing section is vital here).
- Aural comprehension, e.g.: giving the learners some questions in advance, with the answers being contained in a taped passage that they then have to listen to; letting them listen to a taped passage first and then asking questions; making them summarise a passage to which they have listened; and so on.
- Role-playing exercises, e.g. exercises in which the learner first has to listen to a section of dialogue (preferably twice), this then being replayed with one of the roles missing so that the learner can participate.
- Games, e.g. quizzes based on true/false responses or multiple-choice answers, or guessing games in which the learner is given a series of clues and then has to supply the answer.
- Specific linguistic activities, e.g. asking the learner to persuade someone to do something, explain something, complain about something, and so on.
- Changing passages from direct to indirect speech.

When it comes to the actual production of material for language laboratories, one of the most important things to remember is that the *pauses* are just as important as the *spoken content*, both in terms of their position and in terms of their length. It is probably best to start by recording all the spoken material, without pauses, and then

to edit this material onto a master tape, incorporating the pauses as you do so. This will enable you to concentrate on one thing at a time – always a good idea in audio work.

In the case of an audio-active laboratory, it is normally only necessary to prepare a single copy of the master tape. In the case of an audio-active comparative laboratory, on the other hand, there will be many occasions when it is necessary to provide the students with their own copies of the recorded material. This can either be done in advance, by preparing multiple copies from the master tape, or can be done at the time of the lesson, by playing the relevant sections(s) of the master tape at the master console and having the students record the material on their individual machines.

Further Reading

1. *Teaching with Tape*, by J. G. Jones; Focal Press, London, 1972. (One of the best standard books on the use of audio materials.)

2. *The Audio-Tutorial Approach to Learning*, by S. N. Postlethwaite, J. Novak and H. Murray; Burgess, Minneapolis; 1972. (Another standard work that anyone using audio-tape for managing individualised learning should find extremely useful.)

3. *Guidelines on Audiorecording*, by N. Nichol; Scottish Council for Educational Technology, Glasgow. (An extremely useful series of leaflets covering many aspects of audiotape recording.)